

# Camera Simulator

## Fact Sheet



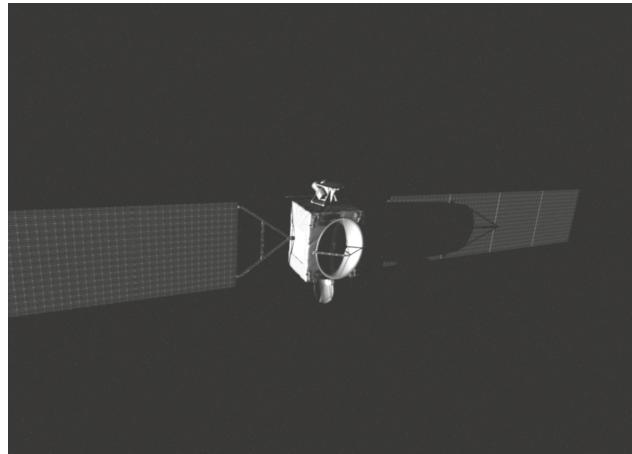
### Applications

- Generation of photo-realistic images based on 3D graphics
- Generation of raw depth maps for LIDAR sensor modelling
- Simulation of sensor input in early design phases, when the mechanical design is not yet fixed and satellite mock-up manufacturing is not viable
- Test and development of image processing algorithms and hardware with realistic input data
- Emulation of imaging and LIDAR sensors in real-time closed-loop GNC simulations
- Landing as well as Rendezvous and docking simulators
- Generation of AI training data (including ground truth data)



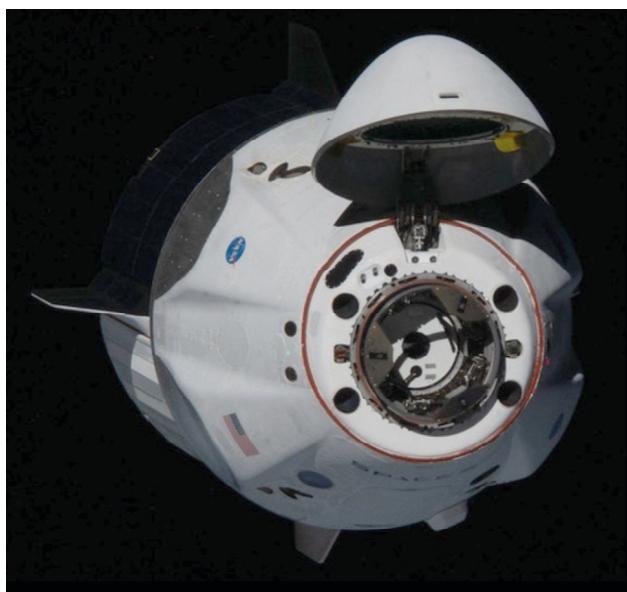
### Benefits

- Cost and risk mitigation due to early identification of design errors
- Test of many (virtual) cameras or LIDAR configurations in short time without extra cost
- Easy integration into real-time GNC simulation environments
- Fast generation of hundreds of thousands of AI training data sets



*Example images in true color and IR monochrome*

*Photo of the Dragon capsule on the left and similar scene generated by the camera simulator on the right*



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### Features

#### Support for various sensor types

- Monochrome and colour cameras
- NIR to thermal IR cameras
- Scanning and flash LIDAR
- Photo sensors (e.g. sun sensors, solar arrays)

#### Realistic scenario simulation:

- Surface materials
- Reflections & shadowing
- Atmospheric scattering
- (Irregular) celestial bodies and star catalogue
- Sunlight, albedo & artificial light sources (HDR)

#### Simulation of camera characteristics

- Depth of field
- Amplifier noise
- Defective pixels
- Wavelength spectrum
- Radial distortion

#### Scene generation

- Procedural boulder and crater generation with localized size and density distribution
- Bezier mesh refinement for user-provided surface grids
- Artificial multi-layer surface modelling

#### Meta-data output

- Distance and time information
- Surface normals
- Artificial scene data (e.g. rock locations and size)
- Meta data can be overlaid or is provided via TCP/IP

#### Run-time controllability

- Physical effects
- Camera characteristics
- Scene generation parameters
- Temperature of thermal nodes

#### Various operational modes

- Fixed frame rate and triggered image data generation
- Flexible output formats (image/video)
- Trajectory and attitude import as well as real-time trajectory and attitude data interfaces
- Mathworks® Simulink® block for easy interfacing

#### Multiple vehicles and articulations

- Rendezvous scenarios
- Robotic arm operations
- Movable solar arrays and radiators



Original mesh (left), refined mesh with boulders & craters (middle) and meta data (right; here: surface normals)